MULTIMEDIA UNIVERSITY

STUDENT ID NO

SEAT NO: _____

SECTION: TC01 / TC02 / TC03

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

TCP2101 – ALGORITHM DESIGN AND ANALYSIS

(All Sections / Groups)

5 MARCH 2019
09.00 – 11.00
(2 Hours)

Question	Mark
1	
2	
3	
4	
Total	

INSTRUCTIONS TO STUDENT

1. This Question paper consists of 12 pages with 4 Questions only.

2. Answer all **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in **this Question paper.**

Question 1

a) Explain briefly what is **uniform hashing**. Among the two hash functions below, which hash function do you think is better for uniform hashing? Explain your answer. [4 marks]

(1) h(k) = k % 101
(2) h(k) = k % 128

b) An algorithm named ***LMN*** is provided below. Fill in the column named Number of Primitive Operations, and then find the time complexity $T(n)$ of the algorithm in big-O notation. [7 marks]

Algorithm LMN(*A*, *n*) Input: *A* is an array with *n* integers	Number of primitive operations in big-O notation
for *i* ← *n*-1 to 0 do	
for *j* ← 1 to *i* do	
If *A*[*j*-1] > *A*[*j*]	
temp ← *A*[*j*-1]	
A[*j*-1] ← *A*[*j*]	
A[*j*] ← *temp*	
{increment counter *j*}	
{decrement counter *i*}	
return *A*	
$T(n)$	

Continued...

c) What is the function of this algorithm ***LMN***? Given an array $A = \{7, 2, 9, 3, 9, 4\}$, **write the output** of the algorithm on this array A. [3 marks]

d) Insert the elements in the following order: 34, 55, 12, 17, 45, 37, 75, 86, 65, 21 into a hash table using the hash function, h(x) = x % 19. Use quadratic probing to handle collisions in this hash table. What is the load factor for this hash table? [7 marks]

Continued...

e) Which traversal method outputs **sorted result** in a binary search tree (BST)? Write the pseudocode for this traversal method. [4 marks]

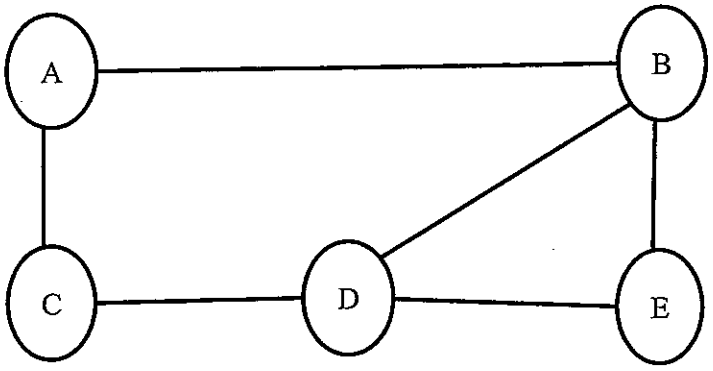
Question 2

a) The following matrix chain is given: **A1**: 8 x 12, **A2**: 12 x 7, **A3**: 7 x 5, and **A4**: 5 x 11. Use **dynamic programming** to solve this matrix multiplication problem. Fill up the following table with the optimal solution calculated using dynamic programming. Show your workings clearly. [8 marks]

	A1	A2	A3	A4
A1				
A2				
A3				
A4				

Continued...

b) Spanning trees are produced when **Depth-First Search** is applied to the graph below (start vertex A). **Draw** all possible spanning trees. [4 marks]



Continued...

c) State whether the following statement is true or false. Explain your answer using time complexity. [2 marks]

Both **adjacency list** and **adjacency matrix** have the **same** time complexity when inserting an edge into a graph.

d) Show in steps how to use **SelectionSort** to sort the sequence provided below. **Explain** briefly why SelectionSort is faster or slower than MergeSort. [6 marks]

```
61 30 7 44 25
```

e) Show in steps how to use **RadixSort** to sort the sequence *S* provided below. State one **disadvantage** of RadixSort when compared with QuickSort. [5 marks]

```
S = {(2,b), (11,c), (2,a), (39,d)}
```

Continued...

Question 3

a) Show in steps how to use **MergeSort** to sort the following sequence. State the worst-case **time complexity** for MergeSort. [4 marks]

```
61 30 7 44 25
```

Continued...

b) QuickSort has two steps: quicksort (recursive), and partition. Write the pseudocode for the quicksort step. You may refer to the following header, input, and output.

[4 marks]

```
Algorithm quicksort (S, p, r)
  Input: Array S, start index p, end index r.
  Output: S is sorted.
```

c) Provide sample data (array) and pivot that trigger **worst-case** in **QuickSort.**

[2 marks]

d) Use the Master Theorem to find the running time for the following two recurrence equations. The three cases of the Master Theorem are given below. [6 marks]

1. if $f(n)$ is $O(n^{\log_b a-\varepsilon})$, then $T(n)$ is $\Theta(n^{\log_b a})$
2. if $f(n)$ is $\Theta(n^{\log_b a}\log^k n)$, then $T(n)$ is $\Theta(n^{\log_b a}\log^{k+1} n)$
3. if $f(n)$ is $\Omega(n^{\log_b a+\varepsilon})$, then $T(n)$ is $\Theta(f(n))$,
   provided $af(n/b) \le \delta f(n)$ for some $\delta < 1$.

Continued...

i) $T(n) = 16T(n/4) + n^2$

ii) $T(n) = 3T(n/3) + n^3$

e) The **knapsack** problem has the following six items shown in the table below; each having its weight and benefit. You are allowed to take **fractional amount** of an item. Find the maximum total benefit with weight (W) of at most **11**kg. List the **selected items** and the **maximum total benefit**.

[9 marks]

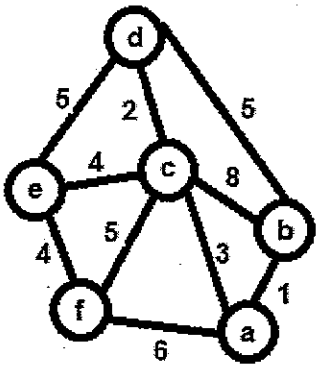
Item	A	B	C	D	E	F
Weight (kg)	2	2	3	4	3	8
Benefit	30	6	12	24	21	16

Continued...

Question 4

a) What is the main difference between **fractional knapsack** problem **and 0/1 knapsack** problem? State the **algorithm design technique** that produces **optimal solution** for fractional knapsack problem and 0/1 knapsack problem respectively.
[4 marks]

b) The following graph is provided. Use **Dijsktra**'s algorithm to find all shortest paths from vertex ***a***. Show the **intermediate results** (steps) in your answer.
[10 marks]



Continued...

c) State **one similarity** and **one difference** between complexity classes P and NP.
[3 marks]

Continued...

d) String X is provided as below. Use Huffman Encoding to calculate how many **bits** are required to encode X? Show your workings clearly. [8 marks]

X = SSPCSWSSP

End of Page